MULTIMEDIA UNIVERSITY

STUDENT ID NO

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MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2017/2018

ETN2126 – INFORMATION THEORY AND ERROR CODING

(TE, MCE)

03 MARCH 2018
9.00 a.m. – 11.00 a.m.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 5 pages with **FOUR** (4) Questions only.
2. Attempt ALL **FOUR** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please print all your answers in the Answer Booklet provided.

Question 1

(a) A discrete memoryless transmitter (DMS) transmits symbols $\{s_0, s_1, s_2\}$ with a probability of {0.2, 0.35, 0.45}.

(i) Calculate the source entropy for the DMS.

[2 marks]

(ii) Calculate the source entropy for the DMS by extending it into blocks of 3 symbols/block.

[2 marks]

(iii) Discuss how using extended DMS source affects the source entropy.

[3 marks]

(b) Matrix, ***P***, shows the channel matrix of a discrete memoryless channel that has input symbols which are equally probable.

Given that $H(A_x \mid y_0) = H(A_x \mid y_1) = H(A_x \mid y_3) = 0$ and $H(A_x \mid y_2) = 0.459932$, calculate the mutual information of the channel, $I(A_X; A_Y)$.

$$P = \begin{bmatrix} p(y_0 \mid x_0) & p(y_1 \mid x_0) & p(y_2 \mid x_0) & p(y_3 \mid x_0) \\ p(y_0 \mid x_1) & p(y_1 \mid x_1) & p(y_2 \mid x_1) & p(y_3 \mid x_1) \\ p(y_0 \mid x_2) & p(y_1 \mid x_2) & p(y_2 \mid x_2) & p(y_3 \mid x_2) \end{bmatrix} = \begin{bmatrix} 0.25 & 0.00 & 0.75 & 0.00 \\ 0.00 & 0.25 & 0.00 & 0.75 \\ 0.00 & 0.00 & 1.00 & 0.00 \end{bmatrix}$$

[12 marks]

(c) A "CAT-5" twisted-pair cable has a bandwidth of approximately 100MHz. The desired transmit information for a communication system is 500Mbps.

Justify if a Signal-to-Noise Ratio (SNR) of 30dB is sufficient to reliably transmit this much information.

[6 marks]

Continued.....

Question 2

(a) An encoder is designed to encode the following characters:

0000	0001	0010	0011	0100	0101	0110	0111
A	B	C	D	E	F	G	H
1000	1001	1010	1011	1100	1101	1110	1111
I	J	K	L	M	N	O	P

If the encoder uses the following generator matrix:

$$G = \begin{bmatrix} 1 & 1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 1 & 0 & 0 \\ 1 & 1 & 1 & 0 & 0 & 1 & 0 \\ 1 & 0 & 1 & 0 & 0 & 0 & 1 \end{bmatrix}$$

(i) Encode the message "**BIN**".

[6 marks]

(ii) Use syndrome decoding and subsequent error corrections to determine the transmitted message for the received symbols y_1, y_2 and y_3 below.

$$y_1=0101000, y_2=0000101, y3=1001110$$

[8 marks]

(b) A transmitter transmits five symbols. Symbols ***S1*** and ***S2*** each has a 35% chance of occurring, while ***S3***, ***S4*** and ***S5*** have equiprobable chances of occurring. Design the *most efficient* Huffman code for the transmitter.

[9 marks]

(c) Discuss how error coding increases transmission reliability.

[2 marks]

Continued.....

Question 3

(a) The signal transmission in **Figure 1** is transmitted by a 8-PSK transmitter. Design a code using *set partitioning* to determine the signal transmission shown in **Figure 1.**

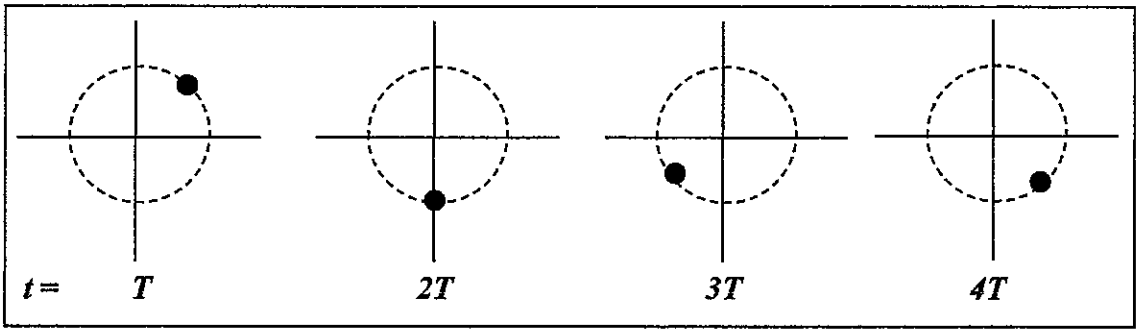

Figure 1

[10 marks]

(b) The block diagram in **Figure 2** shows a Trellis Coded Modulation (TCM) system with a rate 1/2 convolutional encoder connected to a 8-PSK signal mapper.

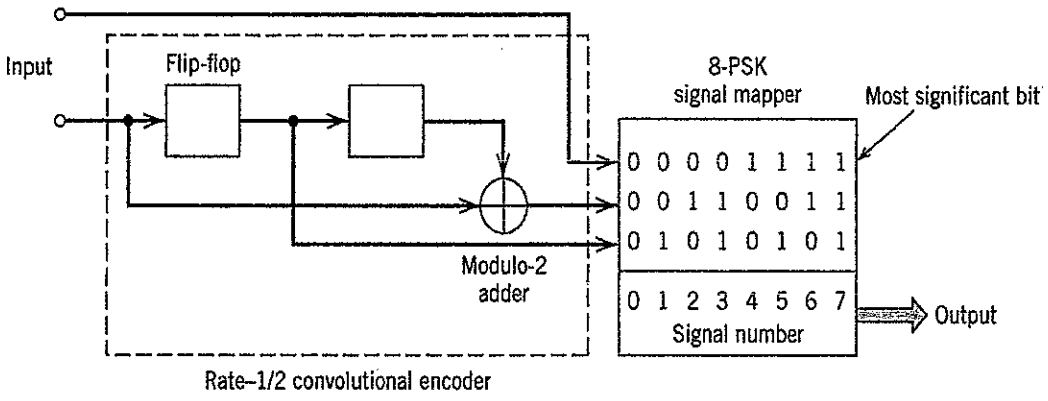

Figure 2

(i) Design the trellis diagram for the convolutional encoder.

[10 marks]

(ii) If the output of the TCM system is 010 101 100 011 110, find the corresponding input data sequence *into the TCM system.* You are required to highlight the path of the codeword in the trellis diagram clearly.

[5 marks]

Continued.....

Question 4

(a) A convolutional encoder is shown in **Figure 3.**

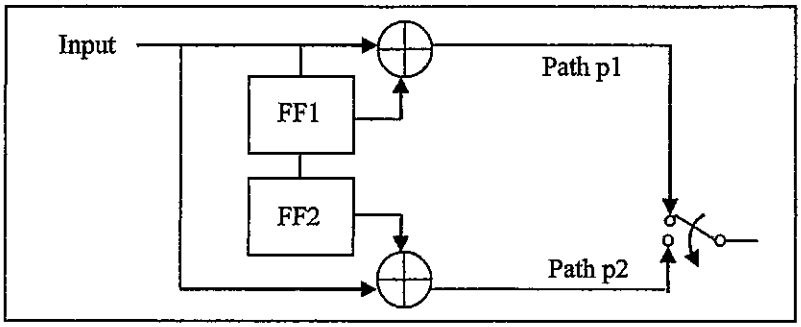

Figure 3

(i) Determine the constraint length and the code rate for this convolutional encoder.

[4 marks]

(ii) Deduce the generator polynomial for Path p2 in **Figure 3.**

[3 marks]

(b) **Table 1** shows the present state and next state of a convolutional encoder.

Table 1

Present Encoder State	Input Bit	Next Encoder State	Output Bits
00	0	01	00
00	1	10	01
01	0	11	11
01	1	00	10
10	0	01	00
10	1	00	11
11	0	10	10
11	1	11	01

(i) Draw the state diagram and indicate clearly the encoder output for inputs 0 (solid line) and 1 (dotted line).

[8 marks]

(ii) Based on the state diagram from part (a) (i), find the encoded sequence for the input bits 0 1 0 1 1. The initial state of the registers is given as **11.**

[10 marks]

End of Paper